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SUBJECT: A VISIT TO SWEDEN'S BIOREFINERY COAST

¶11. Summary: During a March 10-11 trip to three cities on the north east coast, embassy staff visited the heart of a traditional export industry - paper and pulp - in the process of redefining itself. These large paper and pulp mills are developing biofuels from previous waste by-products: ethanol from wood chips and methanol from "black liquor" (a waste wood by-product). They are seeking government support to commercialize their new biofuels. Some companies we visited were already on the embassy's "A-list" of alternative energy companies, others were not. Lulea University of Technology provided an in depth report on their renewable energy related research and also pointed out the numerous connections with the region's paper and pulp businesses. End Summary.

¶12. On March 10-11, CDA, Commercial Advisor and Economic Section Intern visited Sweden's Biorefinery Coast. The northeastern Baltic coast is home to significant forest resources, paper/pulp mills, universities and technology parks. There is also a strong interaction between government, universities and the private industries. CDA visited the northern cities of Ornskoldsvik, Lulea and Pitea with the objective to discuss the recent progress in the region's research on, and production of, biofuels.

SEKAB - ETHANOL FROM WOOD WASTE

¶13. Sekab is a cutting edge company producing ethanol from feedstocks not used as foods, including wood and sugar cane waste. The process is fast reaching a commercial breakthrough and attracting a substantial commercial interest.

¶14. Sekab is on the Embassy's list of potential Swedish cleantech companies (A-list), compiled as part of the One Big Thing, the U.S. Embassy Stockholm's alternative energy cooperation initiative. Sekab has gone through severe financial turmoil lately due to fluctuations in oil prices and currencies, but is determined to keep focus on the development and production of cellulosic ethanol technology. The company is now looking for an injection of capital or reorganization. Along with the U.S. and Brazil, Sweden is a leading country in the field of biofuel research. During the meeting, CEO Per Carstedt mentioned four growth drivers that will encourage an increased interest in bio-ethanol: farm revenues, energy security, environment and economics. Swedish Prime Minister Fredrik Reinfeldt has set a national target for Sweden to eliminate the use of fossil fuels by 2030. Sekab aims to contribute to Sweden's goal and to reduce the use in the rest of the world by marketing and delivering its cellulose technology worldwide.

¶15. In its current research and small-scale production, Sekab is focusing on softwood, primarily pine, which can yield high output of biofuel but also offers the biggest challenge in the production process. Great work is also being done to produce energy and green chemicals from the paper mills' by-products, such as lignin. By 2011 Sekab aims at having a complete Cellulose Industrial Development Unit. The company has started an initiative called the Verified Sustainable Ethanol Initiative, which aims at securing the supply of verified sustainable ethanol for E85 gasoline to the market until EU regulations are in place to do so. The underlying

message of the initiative is "Traceability from Field to Wheel."

¶6. Sekab sees a great potential in expanding into the African tropical zone, mainly Mozambique and Tanzania, for producing bioethanol. The region offers good conditions for growing sugarcane with bioethanol as one of its products. A bio energy cluster in the region would be globally competitive and provide long term access to Europe. Through carbon capture and storage, CCS, an optimized production system could even be a CO₂ sink.

¶7. Sune Wannstrom, Head of Research, discussed with us the Sekab pilot plant. The plant is a complete cellulose-to-ethanol system, presently holding a capacity of 2 tons of dried wood chips/24 hrs. The plant is developed by Sekab technology but is co-owned with holding companies of Ume University and Lule University of Technology. It has more than 17,000 hours of operation and at the time of the visit the plant had had ten days of uninterrupted operation.

HAGGLUNDS - A HYBRID MILITARY VEHICLE

¶8. Hagglunds, part of the British weapons manufacturer BAE Systems Group, primarily produces infantry fighting vehicles, armored all-terrain vehicles and turret systems. The focus of our visit, the Electric Hybrid Drive Technology, provides fuel economy, is less harmful to the environment and allows a silent approach on military target. The system has advanced energy storage, electric traction drive, power generation, regenerative braking, and integrated power management technology. By expanding the technology to also fit the non-military sector, the company believes it to be a strong competitor to the existing technologies. Interesting non-military projects are being done in cooperation with Arlanda Airport, Volvo

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Construction Equipment and Ume University.

LULEA UNIVERSITY OF TECHNOLOGY

¶9. Lulea University of Technology (LTU) has a focus on leading edge and applied research in multiple disciplines. The faculty of engineering covers 53 research subjects and has close ties to industry, including energy related research such as wind energy, energy savings/process integration within the process industry, district cooling using snow, and pulp mill based biorefinery research. The two main research partners are Energy Technology Center (ETC) in Pite and Metallurgical Institute (MEFOS) in Lulea.

¶10. Dr. Joakim Lundgren described the global bioenergy challenges to include biomass combustion. The university has a research focus on small to medium heating appliances and combined heat and power plants. Within the area of biomass gasification the university's research is mainly focused on transforming pulp and paper mills to biorefineries by adding black liquor gasification technology. This enables the plants to produce electrical power, fuels and valuable chemicals at competitive prices in addition to pulp and paper. Developing, evaluating and improving gasification technologies for refining of available regional biomass feedstock for local product consumers is also on the agenda.

¶11. Prof. Staffan Lundstrom introduced the university's hydropower research, which focuses on research turbines and pressure measurements in hydropower applications. The new climate situation has led to an increased importance of dam safety and aquaculture protection and new regulation paradigms are in place due to the increased amount of renewable energy. Internal erosion in embankment dams is a threat to the dams. The region also offers high potential for land-based wind power and LTU hopes to open a research center for wind power in cold climates.

¶12. Prof. Kris Berglund covered the topic of producing ethanol through biomass fermentation. He claimed little attention is being paid to value-added derivatives that can leverage the capital investments for ethanol plants, namely green chemicals production.

A chemical business that is parallel to fuel ethanol would offer diversification as well as stable margins. Fermentation is however a relatively expensive and capital equipment intensive process. Thus we need to make sure that the end product can support the costs of the technology. Berglund has founded a company, "Working Bugs," which produces micro-thin membranes used in producing green chemicals and biofuels.

CHEMREC - METHANOL FROM PAPER TO PULP MILLS

¶13. Chemrec, also on the Embassy's A-list of Swedish alternative energy companies, is helping pulp and paper mills transform into biorefineries through black liquor gasification technology. Since paper mills already produce black liquor in large quantities as a pulp by-product, the technology does not compete for food or agricultural land. In Pitea, where the visit took place, the Chemrec gasification plant is located next to Smurfit Kappa Kraftliner paper mill. The gasification plant produces second generation vehicle fuel (methanol and DME) from forest biomass and has been in operation since 2006. The mill also has another biorefinery development project starting in 2010, aimed at producing biodiesel from tall oil.

¶14. Chemrec has since 1996 had a booster gasifier for black liquor recovery at the Weyerhaeuser New Bern plant in North Carolina, U.S. Their new gasifier technology will also be producing methanol at the New Page plant in Escanaba, MI. Chemrec is looking into funding opportunities from DoE and USDA and has extensive cooperation with U.S. companies.

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